Assessment of the Potential Costs and Energy Impacts of Spill Prevention, Control, and Countermeasure Requirements for Nuclear Power Plant Emergency Diesel Generator Tanks

Report Prepared for the

U.S. Department of Energy
Office of Fossil Energy

By

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May 2006

Nuclear Power Plant Emergency Diesel Generator Tanks[1]

1. Sector Description

Nuclear power provides about 20% of the total electricity generated in the United States. In 2005, this was about 782 Billion kWh of the total electricity generation (EIA 2006).[2] As with fossil-fueled electricity generating plants, electricity in a nuclear power plant is produced by heated steam that drives a turbine generator. In a nuclear power plant, however, nuclear fission reactions in the core produce heat that is absorbed by a liquid that flows through the system and is converted to steam.

Nuclear power plants are highly efficient and have become more so over the last 25 years. Operational efficiency (also referred to as plant performance or electricity production) can be measured by the capacity factor. The capacity factor is the ratio of the actual amount of electricity generated to the maximum possible amount that could be generated in a given period of time – usually a year. Today, nuclear power plants operate at an average 90% capacity factor (compared to 56 % in 1980) (EIA 2006a). Thus, although nuclear generating capacity has remained roughly constant since 1990, at about 99 gigawatts (or about 10% of the total U.S. electric generating capacity), the amount of electricity produced has increased 33% since that time because of increased capacity utilization. Nuclear plants have the highest capacity factors of any electricity generating source.[3]

There are 103 operating nuclear power plants in 31 states. They range in capacity from 476 MW to 3,804 MW, with the average capacity around 1,000 MW. Figure 1 shows the locations of these plants.

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[1] This paper addresses energy impacts of SPCC rule compliance on underground storage tanks at nuclear power plants. A separate paper addresses secondary containment requirements impacts on electric utility substations. DOE had originally intended to prepare a third paper for wind turbines but has since decided to include these in the electric utility substation paper.
[2] The total of 4,000 billion kWh of electricity generation includes electricity generated by independent power producers and combined heat and power plants. Of the 2,500 billion kWh generated by electric utilities, nuclear plants contributed about 31% (EIA 2006b)
[3] Average approximate capacity factors for electricity generating plants using other fuels are coal -- 70%, natural gas plants (gas turbines) -- 16% natural gas plants (combined cycle) -- 38%, oil and hydro -- 30%, wind -- 27%, and solar -- 18% (NEI 2006).

Figure 1. Locations of Nuclear Power Plants in the United States
Source: NEI 2006

1.1 Emergency Diesel Generator Storage Tanks Description

As noted, nuclear power plants produce electricity through nuclear fission. Since the fission process creates radioactivity, all nuclear power plants have many safety systems to protect workers, the public, and the environment. For example, some systems allow the fission process to be stopped and the reactor to be shut down quickly; other systems cool the reactor and carry heat away from it.

During operations, nuclear power plants rely upon electricity generated and transmitted from offsite sources to provide the power needed to operate the reactor's safety systems. Without these systems in operation, even when the reactor is shut down, the thermally hot and radioactive fuel inside the reactor could quickly overheat and lead to a nuclear emergency.

If offsite power is lost (for example, due to a failure on the electricity grid), the reactors are designed to switch automatically to backup emergency diesel generators (EDGs). EDGs are locomotive-sized generators that provide power to operate a basic set of reactor safety systems. Each reactor unit is required to have at least two emergency diesel generators onsite. Should these backup generators fail (e.g., due to fouling of the diesel fuel, overheating, mechanical failure) a smaller subset of vital reactor cooling instrumentation and control systems would rely on power from large, on-site battery banks. Battery depletion and subsequent loss of vital instrumentation can occur after approximately 4 hours. The failure of both onsite and offsite power supplies results in "station blackout." According to the Nuclear Regulatory Commission (NRC), station blackout sequences are the largest contributors to core damage frequency. Among other things, station blackout can result in the unavailability of the high-pressure injection system, the containment spray system, and the inside and outside containment spray recirculation systems that are needed to remove core heat (NRC 1990).

The NRC requires nuclear power plants to have enough emergency diesel fuel available to run the EDGs for seven days. The back-up diesel fuel is stored in one or more tanks on the site of each reactor unit in the power plant. Depending on environmental, weather, and other conditions, these tanks can be aboveground (for example, in areas where high water tables make underground storage inappropriate) or underground, (for example, in areas where tornadoes and other severe weather make aboveground storage inappropriate). In most cases, underground storage will be the preferred option because it provides the best way to protect the fuel supply from severe weather, fire, terrorist attacks, etc. The number of nuclear plants with underground EDG storage tanks is not readily available, but it is believed be at least 50%.

Because of their importance to reactor safety, EDG systems, including the diesel fuel storage and supply system and associated tanks and piping, fall under the NRC's definition of nuclear safety-related structures, systems, and components ("SSCs"). SSCs are relied upon to remain functional during and following design basis events[4] to assure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shut-down condition, or the capability to prevent or mitigate the consequences of accidents, which could result in potential offsite exposures. Safety-related SSCs are subject to the highest level of quality control and NRC regulatory oversight (10 CFR 50, Appendix B).

1.2 Sector Economics

Economic efficiency measures how a plant uses scarce resources, and production cost -- the cost of operating the plant -- is a measure of economic efficiency. Production costs include fuel, labor, materials, and services. Nuclear power production costs have been declining over the past 20 years, from 3.63 cents per kWh in 1987 to 1.68 cents per kWh in 2004 (NEI 2006). Of this, .42 cents (25%) is for fuel, with the remainder for operations and maintenance (labor, material and supplies, contractor services, licensing fees, and miscellaneous costs such as employee expenses and regulatory fees). Nuclear power has the lowest production cost of the major sources of electricity. The production cost for electricity generated with coal is 1.9 cents/kWh, natural gas 5.87 cents/kWh, and petroleum 5.39 cents/kWh; for these fuel types, the fuel makes up about 75% of the production costs[5] (NEI 2006).Thus an outage at a nuclear power plant, with its high efficiency (90 % capacity factor) and low production costs, will result in proportionately greater energy losses than would occur at other, less efficient plants.

2 EDG Tanks and the SPCC rules

2.1 EDG Tanks Affected by the SPCC Regulations

The systems within nuclear power plants most affected by the SPCC rules in terms of energy impact are the underground EDG tanks.[6] These tanks fall into the category of bulk storage under both the 2002 rules and the 2005 proposed revisions.[7] In the 2002 rules, EPA provided an

[4] A design basis event is a postulated event (e.g., accident, explosion, fire, flood, earthquake) used in the design to establish the acceptable performance requirements of the structures, systems, and components.
[5] Hydro has a production cost of 0.5 cents/kWh, wind .2 cents/kWh and solar 2.48 cents/kWh (NEI 2006).
[6] Aboveground EDG tanks are covered by the 1973 rules, the 2002 rules, and the 2005 amendments, but the energy effects associated with compliance for the aboveground tanks is not as significant as for underground tanks.
[7] It is not clear whether they were intended to be covered by the 1973 rules, but because (1) those rules were aimed at preventing leaks from aboveground tanks, (2) they were phrased in terms of "should" rather than "must", and (3) they contained no specific mention of underground EDG tanks, the nature and degree of any applicability of the 1973 rules to underground EDG tanks is much less clear than the 2002 rules.

exemption for completely buried storage tanks and associated underground piping and ancillary underground equipment and containment systems if the facility is subject to all of the technical requirements of EPA's Part 280 underground storage tank (UST) rules or an authorized state program under Part 281 (§112.1(d)(4)). EPA explained that the UST rules "provide comparable environmental protection for the purpose of preventing discharges as described in § 112.1(b)" (67 FR 47042, 47064). In the preamble to the 2002 rules, EPA explained that tanks that are exempted or deferred from compliance with the Part 280 rules, which include "any UST system that is part of an emergency generator system at a nuclear power generating facility regulated by the Nuclear Regulatory Commission, remain potentially subject to the SPCC program" (67 FR 47064). In effect, the purpose of the UST exemption was to avoid SPCC regulation of tanks also subject to the technical requirements of the Part 280 UST rules (or state equivalent programs), but EPA did not take similar action for underground EDG tanks subject to regulation under Part 50, Appendix A, of the Nuclear Regulatory Commission's rules.

The number of nuclear power plants with underground EDG tanks is not readily available. However, a random sample of utility companies that operate nuclear plants indicated that at least half have EDG tanks that are underground. Although Section 112.1 (b) limits the applicability of the SPCC rules to facilities, which, due to their location, could reasonably be expected to discharge oil in quantities that may be harmful into or upon the navigable waters of the United States or adjoining shorelines, it can be assumed that the rules would apply to most if not all nuclear plants with underground EDG tanks, because few if any are located in arid, noncoastal areas (See Figure 1). Further, although Section 112.1(d)(2)(i) limits the applicability of the rule to facilities with completely buried storage capacity of more than 42,000 gallons of oil, the EDG tanks are large enough that the combined underground storage at a given nuclear plant would likely exceed the 42,000-gallon limit. Even if the underground EDG oil storage capacity were below 42,000 gallons, if the aboveground oil storage capacity at the facility were at least 1,320 gallons, then the underground EDG tanks would be subject to SPCC regulation. Thus, the 2002 rules, and the proposed 2005 amendments, are assumed to apply to any and all underground EDG tanks.

The table below presents, for various iterations of the rule, the estimated coverage of underground EDG tanks that would be subject to the SPCC requirements and the portions of the rule that result in energy impacts.

Application of SPCC Regulations to Underground EDGs*

	1973 Rule	2002 Rule	2005 Proposed Amendments
Does the SPCC rule apply to underground EDG tanks at nuclear power plants?	Unclear. The underground storage tank regulations (40 CFR Parts 280 and 281) were promulgated in 1988 and did not exist when the 1973 rule was written. Therefore, it would not have been possible for EPA to exempt (or not exempt) underground EDGs on the basis of their compliance (or noncompliance) with the Part 280 and 281 rules. It is assumed that any EDG tank would meet the location threshold, i.e., "that due to its location could reasonably be expected to discharge oil in harmful quantities, as defined in Part 110 of this chapter into or upon the navigable waters of the United States or adjoining shorelines." However, the language in the 1973 rules was much less definitive than the 2002 rule. The requirements for secondary containment in the 1973 were that "appropriate containment and/or diversionary structures or equipment to prevent discharged oil from reaching a navigable water course ***should*** be provided" (§112.7(c)). Thus, it is not clear whether the specific provisions in the SPCC rules were enforceable rules or advisory guidelines.	Yes. § 112.1(d) (2) (i) exempts completely buried storage capacity that is currently subject to all of the technical requirements of 40 CFR Part 280 (Underground Storage Tank program) or 40 CFR Part 281 (approved state underground storage programs). However, underground EDG tanks at nuclear power plants do not qualify for this exemption, because their compliance with Part 280 and Part 281 has been deferred. As stated in the preamble (40 FR 47064), facilities with storage capacity subject to Part 280 that are deferred from current compliance with most of the technical requirements of Part 280 include . . . "any UST system that is part of an emergency generator system at a nuclear power generation facility regulated by the Nuclear Regulatory Commission under 10 CFR Part 50, Appendix A. The preamble also states that "an UST system includes the tank itself, connected underground piping, underground ancillary equipment, and containment system." It is assumed that any underground EDG tank at a nuclear power plant would meet the location threshold (i.e., that due to its location could reasonably be expected to discharge oil in quantities that may be harmful into or upon the navigable waters of the United States or adjoining shorelines** (§112.1(b)).	Yes. The amendments make no changes to § 112.1 (d) (2) (i) in the 2002 rule.
Under what category are underground EDG tanks?	If applicable, tanks.	Bulk storage containers (any container used to store oil.)	Same as 2002 rule.

	1973 Rule	2002 Rule	2005 Proposed Amendments
What are the oil storage thresholds for the rules to be applicable?	42,000 gallons for total underground storage and 1,320 gallons aggregate storage, with no single container having a capacity greater than 660 gallons (§112.1(d) (3) and (4)). All nuclear plants are assumed to have oil storage capacities greater than the thresholds.	42,000 gallons for completely buried storage capacity and aggregate aboveground storage capacity of 1,320 gallons. All nuclear plants are assumed to have oil storage capacities greater than the thresholds.	Same as 2002 rule.
What SPCC regulatory requirement(s) for EDG tanks result in energy impacts?	Energy impacts are not expected to result from the 1973 SPCC rules. • Secondary containment is not necessarily required for underground EGD storage tanks: For onshore facilities, "appropriate containment and/or diversionary structures or equipment to prevent discharged oil from reaching a navigable water course ***should*** be provided" (§112.7(c)). • If installing secondary containment is impracticable, the rules provide for alternative compliance measures, but additional testing requirements are not part of these alternative measures (§ 112.7 (d)).	Energy impacts are expected to result from secondary containment requirements and from required testing if secondary containment is not practicable. • Secondary containment for onshore facilities as described in §112.7(c): Owner/operators ***must*** "provide appropriate containment and/or diversionary structures or equipment to prevent a discharge as described in §112.1(b). The entire containment system, including walls and floor, ***must*** be capable of containing oil and must be constructed so that any discharge from a primary containment system . . . will not escape the containment system before cleanup occurs. • Inspection and leak detection requirements ("periodic integrity testing of the containers and periodic integrity and leak testing of the valves and piping) if the installation of secondary containment is not practicable (§112.7(d)).	Same as 2002 rule.

* The italicizing and bolding of certain words in this table has been done by the author for emphasis.

** Or into or upon the waters of the contiguous zone, or in connection with activities under the Outer Continental Shelf Lands Act or the Deepwater Port Act of 1974, or that may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States (including resources under the Magnuson Fishery Conservation and Management Act) (§112.1 (b)).

2.2 SPCC Compliance Requirements for EDG Tanks

The SPCC requirements with the greatest energy impact for EDG tanks are the secondary containment requirements, followed by integrity and leak testing requirements.

2.2.1 Secondary Containment

Section 112.7 (c) in the 2002 rule (and the proposed 2005 amendments) requires that owners and operators of facilities subject to the rule provide "appropriate containment and or diversionary structures or equipment to prevent a discharge as described in section 112.1(b)." To retrofit secondary containment to existing underground components would likely require excavation and removal and replacement of existing components with double-walled tanks and piping. However, at many nuclear plants, there may be insufficient space to install a completely new system without first removing the old system to make room, thus increasing the cost, time and impracticality of this work.

Further complicating the effort to install secondary containment at EDG tanks, and more importantly from an energy-supply perspective, is that NRC operating license conditions and nuclear safety considerations would require the plants to be taken off-line and placed in a cold-shutdown condition for virtually the entire duration of the EDG fuel system work. It is also possible that for safety reasons, a full core off-load would be needed. The work could easily take several months to complete -- much longer than a normal refueling outage. Having the EDG's out of service would also interfere with other critical refueling outage activities, and it may not be possible to conduct the EDG tank and piping work concurrently with a normal plant outage.[8]

2.2.2 Integrity and Leak Testing Requirements

Section 112.7(d) of the 2002 rule provides that if secondary containment is impracticable, "you must clearly explain in your Plan why such measures are not practicable; for bulk storage containers, conduct both periodic integrity testing of the containers and periodic integrity and leak testing of the valves and piping." (Section 112.7(d) of the 1973 rule did not contain the provisions for periodic testing of containers, valves, or piping.) In the preamble to the 2002 rule, EPA describes the very limited conditions in which an impracticability determination may be allowed: "We do not believe it is appropriate to allow an owner or operator to consider costs or economic impacts in any determination as to whether he can satisfy the secondary containment requirement. . . . . the purpose of a determination of impracticability is to examine whether space or other geographic limitations of the facility would accommodate secondary containment; or, if local zoning ordinances or fire prevention standards or safety considerations would not allow secondary containment; or, if installing secondary containment would defeat the overall goal of the regulation to prevent discharges as described in § 112.1(b)" (67 FR 47104).

[8] There are times during refueling when the EDGs must be available for safety reasons. For example, when the reactor vessel head is first removed for refueling, decay heat remains in the core. Cooling pumps and heat exchangers are needed to prevent the decay heat in the core from boiling the water out of the open vessel, causing an airborne radioactive release or fuel damage. These are supplied with back-up power by the EDGs.

Thus, even if the nuclear plant is able to obtain an impracticability determination for installing secondary containment under the 2002 rules, it must, among other things, conduct both periodic integrity testing of the containers and periodic integrity and leak testing of the valves and piping. The preamble to the 2002 rule describes these testing requirements as follows: ‘‘Periodic’’ testing means testing according to a regular schedule consistent with accepted industry standards. Leak testing for purposes of the rule is testing to determine the liquid tightness of valves and piping and whether they may discharge oil. ‘‘Integrity testing’’ is any means to measure the strength (structural soundness) of the container shell, bottom, and/or floor to contain oil and may include leak testing to determine whether the container will discharge oil. Facility components that might cause a discharge as described in § 112.1(b) include containers, piping, valves, or other equipment or devices, inside and outside of the container. It also includes frequent observation of the outside of the container for signs of deterioration, leaks, or accumulation of oil inside diked areas. Such testing is also applicable to valves and piping (67 FR 47104-47105).

Leak testing presents unique problems for nuclear power plants. Nuclear safety and operational considerations preclude the installation of "off-the-shelf" leak monitoring systems. Further, the EDG fuel systems at nuclear plants are too large and complex for commercially available automatic tank gauging systems (ATG)[9] and piping system monitors. Pressure testing is seldom a viable option because EDG fuel system piping configurations, valve designs, system isolation points, etc. were designed for system safety and operational reliability, not for ease of testing. Pressure testing of these systems requires valves to be locked down for extended periods of time, rendering portions of the EDG fuel system inoperable. In most cases, performance of these tests would also require the plant to be off-line or at least under a "Limiting Condition of Operation," which the NRC views as a degraded safety condition. Other options such as chemical tracer additives have been evaluated and rejected due to possible adverse impacts to the EDGs or other system components in an emergency.

3 Potential for Energy Supply Disruptions from SPCC Requirements for Underground EDG Tanks

Disruptions in electricity supply stemming from the installation of secondary containment for underground EDG tanks at nuclear power plants are virtually assured, and disruptions resulting from tank integrity and leak testing requirements can be expected.

[9] ATG systems use sophisticated in-tank probes to monitor product temperature and product level to within hundredths of an inch. However, these systems only work well on small tanks. Thus, while loss of a few gallons of product in a small, 5,000-gallon tank might drop the level a couple hundredths of an inch, which is detectable by the instruments, a loss of a few gallons from a larger, 60,000-gallon tank (a typical EDG tanks size) might only represent a few thousandths of an inch drop, which would be too small to detect. The systems also require the tank to be "still," with no product added or removed, for several hours on a small tank. The larger the tank, the longer the still period needed to allow the level to drop enough to detect a leak. Any delivery to or pumping from the tank during the test period invalidates the test, meaning the tank must be completely isolated -- a problem for nuclear EDG tanks that may be needed at any time to respond to an emergency.

3.1 Outages Resulting from Retrofitting of Secondary Containment

The utility industry estimates that installing secondary containment for existing EDGs would require the entire nuclear power plant to be shut down and removed from service for at least 20 to 40 days and up to several months, depending on the NRC operating license requirements regarding SSCs. (As noted, the NRC classifies EDGs as SSCs.)

Nuclear power plants are shut down once every 18 to 24 months to refuel approximately one-third of the reactor. In the 1980s and early 1990s, the average refueling outage lasted about three months. Over the past decade, refueling outage durations have shortened substantially. Now a typical refueling outage lasts just a little over one month (on average, about 38 days). These short refueling times have contributed to the higher capacity factors, allowing the power plants to produce electricity more efficiently than previously and contributing to more efficient electricity production relative to other types of generating plants (e.g., coal).

While some of the retrofitting for secondary containment could probably occur while the plant was shut down for refueling, additional downtime would be expected, and roughly 20 to 40 days would be added to the average 38-day refueling shut down period. (This is because there are times during the refueling when the EDGs must be available for nuclear safety reasons – See Section 2.2.1.)

Removing a large, efficient, baseload plant from the electricity grid for a month or more, on top of the scheduled downtime for refueling, will impact electricity supply. If just one 1,000-MW plant operating at 90% capacity installed secondary containment at an underground EDG tank, the loss of electricity produced by that plant for the 20 to 40 days that the plant was down for the retrofitting would be .43 to .86 billion kWh. [10] In the July 13, 2001 guidance for implementing E.O. 13211, OMB stated that adverse effects could include any of the following: "… reductions in electricity production in excess of 1 billion kWh per year . . ." (Daniels 2001). Thus installation at just two to three average nuclear plants would exceed the threshold for adverse energy impact.

Assuming that a 1,000-MW nuclear plant produces about 7.9 billion kWh per year -- enough to meet the needs of 724,000 residential customers a year -- an outage of 20 to 40 days for retrofitting would be the equivalent to a reduction of about 10% in electricity generation from that plant, or a loss of service for roughly 72,400 households – or the size of a small city.

If 50 nuclear generating facilities (roughly half of the total 103 nuclear plants in the United States are assumed to have underground EDG tanks) needed to have their EDGs retrofitted with secondary containment, the impacts of retrofitting would be much more significant. If all 50 plants were required to install secondary containment in a year's time, the reduction would be equivalent to a loss of service to about 3.6 million households. Spreading the retrofits out over a five-year period (which is not provided for in the regulations, but for practical

[10] The assumptions used to produce these estimates are as follows: Average monthly residential electricity consumption in 2004: 908 kWh (EIA 2006c); Number of hours per year 8,760; Average annual household consumption 10,896 kWh; Average nuclear plant capacity 1,000MW; Average capacity factor 90%; Average annual per plant generation 7.884 billion kWh.

purposes is considered) would result in the equivalent of a loss of electricity to roughly 724,000 households (or the population of five medium-sized cities).

The July 2001 guidance also says that a regulatory action could have a significant adverse effect if it “adversely affects in a material way productivity, competition or prices within a region.” As noted, nuclear power plants tend to be concentrated in certain regions (e.g., upper midwest, northeast, southeast, southwest), and therefore the energy effects of shut downs for retrofitting secondary containment or inspections will also be concentrated in these regions.[11]

Other factors will exacerbate these impacts in certain seasons. Because summer is the peak load season (due to air conditioning), it is unlikely that additional downtime for retrofitting would be possible during this time of year. Thus, it may be that retrofitting could only be scheduled in the off-peak season (and probably only in the spring or fall due to frozen ground in the winter), further compressing the window of time in which retrofits can be conducted and placing even more stress on the grid during these times.

Removing nuclear plants from service will not only require other sources to compensate, putting additional strain on the system, but if nonscheduled shut downs of coal-fired or other non-nuclear plants occur (due to weather, for example) or there are unrelated grid problems, the impacts of shutdowns for retrofitting secondary containment at nuclear plants will be exacerbated. Similarly, if electric utility substations are required to retrofit secondary containment (see issue paper entitled, *Energy Impact Issue Paper – Electric Utility Substations*), the strains and potential outages resulting from the combined construction will compound the loss of electric generating capacity.

Retrofitting may have other unintended consequences that could prolong the outage, exacerbate the strain on the power system, and lead to accidents that would have major health, safety, and energy impacts. For example, during excavation, cables could be cut that would need to be replaced, or other accidents with similar repercussions could occur. At a nuclear plant, such accidents would likely have more severe consequences due to the presence of radioactive materials on site than at non-nuclear power plants.

3.2 Outages Resulting from Integrity and Leak Testing Requirements

As noted, if the nuclear power plant were able to obtain an impracticability determination for installing secondary containment, the rules would require the EDG tank system (including piping and valves) to undergo integrity and leak testing. However, such testing itself will require extensive and time-consuming techniques to accommodate the special circumstances at nuclear power plants. The EDG systems, including the tanks, at nuclear power plants were designed so that the fuel could be sent to the generators as quickly and safely and efficiently as possible in emergency situations. The design of a system with these goals as the primary objective differs from the design of a system with leak testing as the primary objective. Therefore, standard leak testing protocols would need to be adapted to the nuclear power plant. To conduct integrity and leak testing at underground EDG tank systems at a nuclear power plants will require portions, if

[11] While power can be transmitted over long distances, the longer the distance traveled the less efficient and more costly it becomes.

not all, of the EDG systems to be shut down for extended periods of time, rendering them inoperable. To conduct the testing at a UST, the tank must be removed from service, drained, and cleaned; a safe atmosphere for workers must be established; and then a time-consuming UT test from the interior must be conducted. It is possible that plants with multiple, large tanks may be able to conduct the tests one tank at a time while remaining on-line, or complete the testing of one or two tanks within an ordinary refueling outage window and complete the remainder at another time. However, plants that rely on fewer tanks — most likely single-unit plants — will not have this option. In many cases, these tests could require the plant to be off-line or in a limiting condition of operation, which the NRC views as a degraded safety condition.

It is estimated that testing of an underground EDG tank system would take from about 3 to 4 days to a week per tank. Thus, a single-unit nuclear plant with 2 to 3 tanks (not an atypical situation) could require a 10 to 15 day outage. This is about half the projected outage time for installing secondary containment, and so the energy impacts could be expected to be similar but scaled down by a factor of 2. However, whereas the retrofitting of secondary containment is a one-time occurrence, periodic testing is, by definition, a recurring event and therefore, testing-related outages could be expected to occur more than once even under generous inspection intervals. Industry suggests that most underground EDG tanks would be taken out of service and internally inspected at least every 10 years or so (plus/minus to accommodate outage schedules), but it could be more or less often if circumstances warranted.[12] Language in the preamble that establishes a presumptive standard for leak testing at underground EDGs may result in more frequent inspections. Thus, ordinary USTs fall under 40 CFR Part 280, which generally requires UST and piping integrity/leak testing every 30 days, or at a minimum, once per year depending on the circumstances. The discussion of the buried tank testing requirement in the preamble to the SPCC rule cites the leak testing requirements of Part 280 as being "certainly acceptable" for SPCC purposes (67 FR 47118). This tends to establish a presumptive standard for an EPA inspector, wherein Part 280 becomes the de-facto baseline. As a result, some professional engineers, when certifying a nuclear EDG UST integrity testing plan, may decide to default to the Part 280 requirements, with the more frequent inspection intervals, rather than certifying a plant-specific plan to protect themselves from professional and legal challenges, liability, or criticism.

3.3 Impacts of Increased Costs to Install Secondary Containment or Conduct Testing

Although it may be possible to make up the loss in electricity generated from other sources, the costs to do so would be higher on a per-kWh basis, because the per-kWh operating costs are higher for non-nuclear plants than nuclear plants. Thus, given that annual operating and maintenance costs are 1.68 cents per kWh for a nuclear plant and 1.9 cents per kWh from a coal plant (see Section 1.2), the additional costs of providing the power from coal plants (assuming that the coal plants could provide the lost generation) would be about 0.22 cents/kWh X .79 billion kWh per year, or roughly $1.7 million in incremental costs per plant. If the power were made up by natural gas or petroleum-fired plants (which have much higher operating and maintenance costs), the incremental costs could be $33 million or more per plant.

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[12] It is much easier to justify longer intervals between inspections for aboveground storage tanks under API (industry) guidelines because the condition of the tank can be observed visually and because corrosion checks can be conducted with the tank in service by ultrasonic thickness (UT) measurements from the exterior.

As noted in Section 1.2, the O&M costs for nuclear power plants, excluding fuel are about 1.26 cents per kWh. Assuming that the annual generation for a 1,000-MW, 90%-capacity plant is 7.88 billion kWh, estimated per-plant O&M costs (excluding fuel) are about $99 million per year. The estimated costs to retrofit an underground EDG fuel tank system with secondary containment are several million dollars. Thus, on a per plant basis, these retrofitting costs would comprise a significant portion of a plant's O&M budget for the year in which the retrofit occurs. Indeed, it is expected that retrofitting of secondary containment would increase the cost of energy production at any plant requiring such retrofitting by at least 1%. (OMB's July 2001 guidance memo regarding energy effects states that "increases in the cost of energy production in excess of one percent constitutes a significant adverse energy effect.") This could mean that to pay for such retrofitting, other planned expenditures (for example, for further increasing capacity via operational measures) may have to be postponed.

In addition to arranging for more costly replacement power, shutting down nuclear plants increases labor costs and reflects poorly on the plant's NRC "scorecard," which can lead to increased NRC regulatory oversight, operating costs, and insurance premiums. All of these costs will be most likely passed along to the consumers, with potentially increased electricity prices that may force some lower-income consumers to curtail or reduce their consumption. Similarly, increased costs to pay for installation of secondary containment may result in the postponement of maintenance that would have otherwise been undertaken with the money used for secondary containment, or in the postponement of other activities to improve efficiency and increase production.

Any disruption in electricity delivery would have major impacts on commercial, industrial, and residential users. The potential for such disruptions and their impacts should be weighed against the benefits of installing secondary containment. These benefits would presumably be to reduce the risks of spills reaching navigable waters, but the controls that are in place already as a result of NRC requirements should be more than adequate to address any spill-related concerns. Specific requirements are implemented through NRC operating licenses and NRC regulatory guides, as well as ASME Codes and state regulations. These regulations, licenses, and other guidance focus on the specific designs and intricacies of nuclear facility emergency generator UST systems, including corrosion protection, and are more appropriate for EDGs at nuclear power plant than Part 280 or Part 112. Attachment I, which contains excerpts from a document prepared by USWAG for EPA in 2004, details many of these requirements and demonstrates the conclusion that sufficient controls are in place to meet the objectives of the SPCC program.

4 Risks

DOE understands that the SPCC rule are not risk-based. However, it believes that the costs and potential energy impacts associated with installing secondary containment at diesel storage tanks do not warrant the very small, if any, reduction in risks that they would be provided. As noted, diesel tanks at nuclear power plants are monitored and regulated to ensure safety and operational capability under NRC regulations (See attachment I). The risk of losing emergency diesel power that could occur during the installation or required inspection of these tanks and the concomitant loss of electricity to customers is much higher and of more impact on the environment and human health than that which could be gained by installing secondary containment.

5 Interference with Other Agency Actions

The July 2001 OMB guidance regarding energy effects says that a regulatory action could have a significant adverse effect if it “creates a serious inconsistency or otherwise interferes with an action taken of planned by another agency regarding energy.” The 2002 rules (and the 2005 proposed amendments) create at least two such inconsistencies.

> 1. As noted in Section 3.2, EDGs and their associated storage tanks and piping systems are designed with the objective of providing emergency power as soon as possible to the reactor to allow key safety measures to be undertaken and maintained that will ensure the safety and security of the plant operations. Should these safety measures fail, the facility could be damaged to the point where its generating capacity would be removed for months, years, or even permanently. And, as noted, removing an efficient, baseload plant from the nation’s power supply will have a much more significant effect on energy supply than removing a smaller, less efficient, non-nuclear plant.
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> 2. Appendix R to the NRC regulations (10 CFR Part 50) requires nuclear plants to have a fire protection program in place and redundant systems to supply water to fight fires, which typically include diesel-driven fire pumps in case electrical power is lost. These diesel-driven fire pumps typically share their fuel supply systems with the EDGs. Thus, a problem with the diesel generator fuel system could also impair fire-fighting capability. A fire at a nuclear power plant could result in safety conditions that could also lead to a plant shut down removing generating capacity for months or longer.

6 Mitigating options

The suggested mitigating option is to retain the exemption for all USTs, including those for which regulations under Part 280 were deferred. For underground EDGs, this could be accomplished by adding the following paragraph at the end of §112.1(d) in the 2002 rule:

> (7) Any storage tank system that is part of an emergency generator system at a nuclear power generation facility regulated by the Nuclear Regulatory Commission under 10 CFR Part 50, Appendix A.

In addition, the language in the preamble on page 47064 regarding the exclusion for underground EDGs at nuclear power plants, i.e.,

> “any UST system that is part of an emergency generator system at a nuclear power generation facility regulated by the Nuclear Regulatory Commission under 10 CFR Part 50, Appendix A,”

should be removed.

Excluding these tanks would avoid the significant, unnecessary energy impacts that can otherwise be expected if the 2002 rules (and the proposed 2005 amendments) are implemented as written. Excluding these tanks would also be consistent with EPA's practices regarding other regulatory programs, as noted below.

In promulgating the 1988 UST rules, EPA noted several concerns associated with regulating underground EDG tanks at nuclear power plants. These were:

- These tanks are already extensively regulated by the Nuclear Regulatory Commission (NRC).
- Further regulation by EPA could result in an overly burdensome program if the regulations were inconsistent.
- Structural changes to the systems as a result of the UST regulations could result in an amendment to the plant's license.
- Any shutdown of the backup fuel system (e.g., for retrofitting) could result in the entire nuclear power plant being shut down.

Thus EPA said that it was deferring application of the Part 280 requirements "pending completion of a review of the NRC regulations (10 C.F.R Part 50, Appendix A) governing these tanks to determine whether further regulation is necessary to protect human health and the environment or would be inconsistent with NRC regulations . . . " It said that "if this research indicates that the NRC regulations are not adequate or are not as complete as the UST regulations, EPA may require these tanks to be subject to Subtitle I [UST] regulations, or it may develop a separate set of standards applicable to this class of tank" (53 FR 37082, 37113). Since that time, EPA has taken no action to apply these regulations to underground EDG tanks at nuclear facilities nor has it developed a separate set of regulations applicable to these tanks. Hence, it can be concluded that EPA has found that the NRC regulations are adequate and complete and that dual regulation is neither necessary nor desirable.

References

Daniels, M.E., 2001, Memorandum for Heads of Executive Departments and Agencies and Independent Regulatory Agencies, Guidance of Implementing E.O. 13211, M-01-27, July 31.
Edison Electric Institute, 2005a, Key Facts about the Electric Power Industry, Available at www.eei.org.

EIA (Energy Information Administration) 2006a, Nuclear Power: 12 percent of America's Generating Capacity, 20 percent of the Electricity, Available at http://www.eia.doe.gov/cneaf/nuclear/page/analysis/nuclearpower.html

EIA 2006b, Basic Electricity Statistics, Available at http://www.eia.doe.gov/neic/quickfacts/quickelectric.html

EIA 2006c, Expert Answers, Available at http://www.eia.doe.gov/neic/experts/expertanswers.html#Average

NEI (Nuclear Energy Institute) 2006, http://www.nei.org

NRC (Nuclear Regulatory Commission) 1990, Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, December, NUREG-1150, Available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1150/v1/sr1150v1-intro-and-part-1.pdf

USWAG 2004, Letter to Dave Evans, US EPA, from J. Roewer, USWAG, Regarding Dual Regulation of Emergency Generator Tanks at Nuclear Power Stations, February 18.

Attachment I
Excerpts from USWAG Letter to EPA Regarding
Dual Regulation of Emergency Generator Tanks at Nuclear Power Stations[13]

I. Nuclear Regulatory Commission Requirements for Emergency Diesel Generator Systems.

Part 50 establishes the regulations applicable to the NRC's licensing of nuclear power plants. *See* 10 C.F.R. § 50.1 All persons that operate or supervise operation of a commercially owned nuclear power plant must be licensed by the NRC. 10 C.F.R. § 50.10.
Detailed information on the design of the facility, including the emergency diesel generator tanks, must be provided to the NRC as part of the licensing process. 10 C.F.R. §§ 50.33, 50.34. The license, when issued, may include environmental conditions. 10 C.F.R. § 50.36b.

Appendix A to Part 50 contains general design criteria for nuclear power plans – the requirement to provide emergency generation capacity derives from Appendix A – while Appendix B contains quality assurance criteria. The licensee's compliance with these criteria must be incorporated into the license application. *See* 10 C.F.R. Part 50, Appendices A & B, Introduction. As a condition of the operating license, each licensee must develop and implement an ongoing quality assurance program that fully satisfies Appendix B.

Appendix B establishes broad, over-arching requirements, which are then implemented via a myriad of interwoven NRC inspection procedures, technical instructions, program documents, licensee inspection, and surveillance programs, etc. The NRC program is oriented toward achieving defined results rather than prescribing specific implementation measures in its regulations. Although this performance-based approach differs somewhat from the more prescriptive rulemaking approach EPA often employs in its programs, the deviation clause in section 112.7(a)(2) of the SPCC rules seeks to achieve a similar degree of owner/operator flexibility that the NRC achieves for its licensees.

The emergency diesel generator systems, including the diesel fuel storage and supply system and associated tanks and piping, fall under the definition of Nuclear Safety-related Structures, Systems and Components ("SSCs"). "Safety-related structures, systems and components" are defined in the NRC rules as structures, systems and components that are relied upon to remain functional during and following design basis events to assure:
(1) The integrity of the reactor coolant pressure boundary
(2) The capability to shut down the reactor and maintain it in a safe shut-down condition; or
(3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in §50.34(a)(1) or §100.11 of this chapter, as applicable.

[13] In a letter 2004 letter to EPA, USWAG provided a detailed survey of NRC regulations, guidance, inspection manuals and generic letters that demonstrates the comprehensive regulatory system to which emergency diesel generator systems at nuclear power stations are subject (USWAG 2004). Although the EPA and NRC regulatory approaches are different, the survey shows that the NRC program fully addresses each of the objectives of the SPCC program, and that dual regulation of the systems by EPA and NRC is not warranted.

10 C.F.R. § 50.2. Safety-related SSCs are considered critical to maintaining nuclear safety and therefore are subject to the highest level of Appendix B quality control and NRC regulatory oversight.

Appendix B Section II (Quality Assurance Program):

The applicant shall establish…a quality assurance program which complies with the requirements of this Appendix. This program shall be documented by written policies, procedures, or instructions and shall be carried out throughout plant life in accordance with those policies, procedures, or instructions.

The quality assurance program shall provide control over activities affecting the quality of the identified structures, systems, and components, to an extent consistent with their importance to safety.

The program shall take into account the need for special controls, processes, test equipment, tools, and skills to attain the required quality, and the need for verification of quality by inspection and test. The program shall provide for indoctrination and training of personnel performing activities affecting quality as necessary to assure that suitable proficiency is achieved and maintained.

Appendix B Section XI (Test Control):

A test program shall be established to assure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements and acceptance limits contained in applicable design documents. The test program shall I include … operational tests during nuclear power plant or fuel reprocessing plant operation, of structures, systems, and components.

Appendix B Section XVI (Corrective Action):

Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

B. Appendix R to 10 C.F.R. Part 50, deals with fire protection for nuclear power facilities.

This appendix requires nuclear plants to have a fire protection program in place that, among many other things, requires control of combustibles (including prompt clean-up of oil leaks or spills) and training of personnel to respond to fires or emergencies that could increase the probability or consequence of a fire (such as oil spills).

Appendix R also requires redundant systems to supply water to fight fires, which typically include diesel-driven fire pumps in case electrical power is lost. These diesel-driven fire pumps typically share their fuel supply systems with the emergency diesel generators. Thus a problem with the diesel generator fuel system could also impair fire-fighting capability.

We quote from several of the provisions of Appendix R that, despite their focus on fire safety, are also relevant to goals of the SPCC program:

Appendix R Section I (Introduction and Scope):
Criterion 3 of appendix A to this part specifies that “Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.”

Appendix R Section II (General Requirements):
The fire protection program shall extend the concept of defense-in-depth to fire protection in fire areas important to safety, with the following objectives:
• To prevent fires from starting;
• To detect rapidly, control, and extinguish promptly those fires that do occur;
• To provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant.

Appendix R Section III (Specific Requirements):
I. Fire brigade training. The fire brigade training program shall ensure that the capability to fight potential fires is established and maintained. The program shall consist of an initial classroom instruction program followed by periodic classroom instruction, fire fighting practice, and fire drills.

II. Additional Nuclear Regulatory Commission Requirements.

A. The NRC issues Generic Letters (“GL”) as a means to quickly disseminate urgent information or in some cases regulatory requirements to licensees without the delay associated with Federal rulemaking. GL 91-18 contained new NRC inspection manual instructions for NRC Inspectors that established new standards to ensure that licensees promptly evaluate any condition that potentially involved the degradation of a safety-related SSC to determine if there has been any loss of quality or functional capability. STS10OP.STS (Oct. 31, 1991). GL 91-18 was revised in 1997 to provide additional clarification and requirements. STS30DEG.TG (Oct. 8, 1997).

Conditions such as leaks, structural damage, or corrosion to emergency diesel generator system tanks or piping would fall under GL 91-18 and the associated NRC inspection manual procedures. Leaks or conditions that could lead to leaks are serious because they create the potential for loss of the fuel inventory needed to run the emergency diesel generators and for contaminants such as water or dirt to get into the fuel supply. If such a condition arose, the licensee would be required to complete a Justification for Continued Operation (“JCO”) analysis and, if the conclusion was that the degradation to the safety-related SSC would impair or prevent the proper function of the SSC, the plant would have to be placed in a condition where the SSC is not needed until repaired. In the case of the emergency diesel generator fuel supply, this would typically require the plant to be placed in a cold-shutdown condition.

Forced shutdowns of nuclear plants result in huge losses to the utility due to labor costs, lost revenue, and the need to arrange for more costly replacement power. Such events also reflect poorly on the plant's NRC scorecard, which can lead to increased NRC regulatory oversight, operating costs, and insurance premiums. Plant operators implement robust preventive maintenance, inspection, and testing programs to avoid such conditions.

GL 91-18 also requires corrective action and appropriate documentation to prevent recurrence of the degraded condition. If the degraded condition is attributable to inadequate design, maintenance, or repairs, the plant operator would also be subject to NRC enforcement action in the form of fines or other penalties.

Excerpts from the two NRC Inspection Manual documents that are also relevant to the objectives of the SPCC program are:

STS30DEG.TG, § 4.8, Final Corrective Action:

ENFORCEMENT.

If the licensee, without good cause, does not correct the non-conformance at the first available opportunity, the staff concludes that the licensee has failed to take prompt corrective action and, thus, is in violation of 10 C.F.R. Part 50, Appendix B (Criterion XVI) [footnote omitted]. When the NRC concludes that corrective action to implement the final resolution of the degraded or nonconforming condition is not prompt, or that the operability determination is not valid, enforcement action (Notice of Violation, orders) will be taken. Enforcement action may include restrictions on continued operation.

Implementation of complete corrective action within a reasonable time frame does not mitigate the potential for taking enforcement action for the root causes that initially created the degraded or nonconforming condition or for violations of other regulatory requirements. The nonconforming condition may have resulted from (1) earlier changes performed without a 10 C.F.R. 50.59 evaluation or (2) inadequate reviews; or may be a *de facto* change for which the facility never met the [Safety Analysis Report] SAR description. The staff may determine that the "change" from the [Final Safety Analysis Report] FSAR-described condition to the discovered nonconforming condition involved a[n Unresolved Safety Question] USQ (or a [Technical Specifications] TS change), and that enforcement action is appropriate for the time frame up to time of discovery.

STS10OP.STS, § 3.1, Operability Definition:

A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its intended functions, and when all necessary attendant instrumentation, controls, electrical power, cooling to seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train component or device to perform its function(s) are also capable or performing their related support function(s) [internal quotation marks omitted].

* * * * *

§ 3.3, Specified Function(s):

* * * * *

In addition to performing the specified safety function, a system is expected to perform as designed, tested and maintained. When system capability is degraded to a point where it cannot perform with reasonable assurance or reliability, the system should be judged inoperable, even if at this instantaneous point in time the system could provide the specified safety function.

§ 4.0, Background:
The purpose of the Technical Specifications is to ensure that the plant is operated within its design basis and to preserve the validity of the safety analyses, which are concerned with both the prevention and mitigation of accidents. Because both prevention of accidents and the ability to mitigate them must be continuously ensured, the process of ensuring OPERABILITY for safety or safety support systems is ongoing and continuous.
The focus of operability is foremost on the capability to ensure safety.
The process of ensuring operability is continuous and consists of the verification of operability whenever a verification or other indication calls in question the system's or component's ability to perform its specified function.

Verification of operability is supplemented by continuous ongoing processes, such as:
• Day-to-day operation of the facility
• Implementation of programs such as in-service testing and inspection
• Plant walkdowns or tours
• Observations from the control room
• Quality assurance activities such as audits and reviews
• Engineering design reviews including design basis reconstitution.

* * * * *
The determination of operability for systems is to be made promptly, with a timeliness that is commensurate with the potential safety significance of the issue.

§ 5.0, Additional Guidance for Operability Determinations:
* * * * *
Licensees should make an operability determination and take corrective action in the following circumstances:
Discovery of degraded conditions of equipment where performance is called into question.

§ 5.1 Focus on Safety:
The immediate and primary attention must be directed to safety concerns. Reporting and procedural requirements should not interfere with ensuring the health and safety of the public.

§ 5.4 Determining Operability and Plant Safety is a Continuous Decision-Making Process:
Licensees are obligated to ensure the continued operability of SSCs as specified by [Technical Specifications], or to take the remedial actions addressed in the [Technical Specifications]. . . . Operability is verified . . . by day-to-day operation, plant tours, observations from the control room, surveillances, test programs, and other similar activities. . . . The [operability determination] process, in one form or another, is ongoing and continuous.

B. Section 50.65 of the NRC's rules, often referred to as the "Maintenance Rule," requires that licensees have effective monitoring and preventive maintenance programs in place to ensure that safety-related SSC's are operable and will function as designed in an emergency.
The emergency diesel generators and their fuel supply system fall under this program.

Commercial nuclear power plants rely on "defense in depth" to maintain safety by ensuring that there are multiple and redundant means to respond to and mitigate emergencies.
Unplanned loss of critical equipment or systems can degrade this defense in depth by unexpectedly eliminating some of the redundant protections. It is therefore desirable that all maintenance on safety-related SSCs be performed on a pre-planned basis when plant conditions can be established and the risk of removing equipment from service is minimized or eliminated.

The Maintenance Rule is designed to ensure that equipment monitoring and preventive maintenance programs at nuclear power plants are developed and implemented to detect and allow for repair of emerging problems in a deliberate and pre-planned manner, at a time that minimizes operational risk, rather than deferring repairs until the equipment has actually failed, which could occur at a critical time.

The Maintenance Rule also requires plant operators to track and trend equipment availability, failure rates, and equipment out of service times to ensure pre-determined reliability and availability targets are met.

An excerpt from the Maintenance Rule that is relevant to the objectives of the SPCC rule states:
Each holder of a license to operate a nuclear power plant under §§50.21(b) or 50.22 shall monitor the performance or condition of structures, systems, or components, against licensee-established goals, in a manner sufficient to provide reasonable assurance that such structures, systems, and components, as defined in paragraph (b), are capable of fulfilling their intended functions. Such goals shall be established commensurate with safety and, where practical, take into account industry-wide operating experience. When the performance or condition of a structure, system, or component does not meet established goals, appropriate corrective action shall be taken. 10 C.F.R § 50.65(a)(1).

C. NRC Inspection Manual IP 62002 establishes inspection procedures for structures, passive components, and other civil engineering features at nuclear power plants. Tanks, piping, and secondary containment structures for emergency diesel generating systems would generally be covered by this manual.

IP 62002 is one of many NRC inspection procedures that verify licensee implementation of 10 C.F.R. Part 50, Appendix B, and the Maintenance Rule. IP 62002 is noteworthy from the SPCC standpoint because it broadly addresses the types of "passive" equipment and structures of concern to the SPCC rule, such as buried piping and cathodic protection, aboveground pipe supports, concrete and earthen berms, tank or dike liners, etc. As with most NRC inspection procedure manuals, IP 62002 is used as the basis by which NRC inspectors judge the effectiveness of the licensee's own program, i.e., the NRC inspector is checking to ensure the licensee has developed and implemented an acceptable program using plant-specific inspection, testing, and work control procedures. Excerpts from IP 62002 that are relevant to the objectives of the SPCC rule include:

Inspection Objectives:
01.01 Evaluate by visual examination and/or review of licensee documentation the condition of structures, passive components, and civil engineering features that are within the scope of Section 50.65 of Title 10 of the Code of Federal Regulations (10 C.F.R. 10.65), "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.
01.02 Verify implementation of 10 C.F.R. § 50.65 (the Maintenance Rule) with regard to structures, passive components, and civil engineering features, herein referred to as "structures."

Inspection Requirements:
02.01 . . . To meet the requirements of the maintenance rule, structures, passive components, and civil engineering features may be categorized into 10 groups for inspection purposes, on the basis of maintenance requirements, expected degradation, and previous industry observations. Possible inspection groups are as follows:
(a) Containment structures
(b) Concrete (reinforced and prestressed) structures other than containment structures
(c) Intake and pumphouse structures
(d) Masonry walls
(e) Steel structures and connections
(f) Water storage tanks
(g) Dams, embankments, and canals . . . .

Specific Guidance:
03.01(b) Concrete (Reinforced and Prestressed) Structures Other Than Containment1 Structures (e.g. fuel-handling buildings, spent fuel pool areas, diesel generator buildings)
Review the documentation constituting the licensee's maintenance program to ensure that the licensee has implemented goal setting, monitoring, and preventive maintenance for concrete structures other than containment in accordance with the requirements of 10 CFR 50.65.
* * * *
On the basis of previous industry experience documented in NUREG-1522, the following areas should be addressed, as a minimum, in maintenance programs:
1) Condition of concrete slabs, beams, columns, base plates, and foundations
2) Condition of the prestressing system (for grouted and greased prestressing elements)
3) Condition of metallic and nonmetallic liners
4) Leakage through water retaining structures and through portions of structures below grade
5) Differential settlement of walls and foundation slabs . . . .
03.01(e) Buried Piping, Pipe Supports, and Equipment Anchorages
Review the documentation constituting the licensee's maintenance program to ensure that the licensee has implemented goal setting, monitoring, and preventive maintenance for buried piping, pipe supports, and equipment anchorages in accordance with the requirements of 10 CFR 50.65.
* * * *
As a minimum, the licensee's maintenance program should address the following topics for buried piping, pipe supports, and equipment anchorages:

* * * *

The cathodic protection system (CPS) (if present) should be functional. The inspector should review the licensee's documentation and surveillance to ensure that the system is protecting all elements served by the CPS. Licensees should include acceptance criteria for corrosion of piping, pipe supports, and anchorages.

Buried piping maintenance programs should include visual examinations when piping is accessible. Connections and joints of buried piping should show no signs of separation, environmental degradation, or leakage. There should be no appreciable settlement between the piping segments that could inadvertently cause pipe stress and leakage. . . . When leakage is discovered in underground piping, the inspector should review the licensee's inspection methods and corrective actions to ensure the licensee considered both leakage in and leakage out of the pipe in its evaluation.

* * * *

03.01(g) Steel Structures and Connections (including safety-related cranes, crane rails and supporting structures, and blowout panels)

Review the documentation constituting the licensee's maintenance program to ensure that the licensee has implemented goal setting, monitoring, and preventive maintenance for steel structures and connections in accordance with the requirements of 10 CFR. 50.65.

* * * *

As a minimum, the licensee's maintenance program should address the following areas pertaining to steel structures and connections:

** * * *

Acceptance criteria pertaining to corrosion of metal components and connectors to be inspected under the maintenance rule. Connectors are the means of making structural connections and may include welds, rivets, bolts and rods, studs and wire ropes.

03.01(h) Dams, Embankments, and Canals

Review the documentation constituting the licensee's maintenance program to ensure that the licensee has implemented goal setting, monitoring, and preventive maintenance for dams, embankments, and canals in accordance with the requirements of 10 CFR 50.65.

Fluid-retaining structures that provide water storage and transfer areas during normal operating, severe environmental, and accident conditions are considered Seismic Category I "safety-related" structures.

USNRC Regulatory Guide 1.127 provides inspection guidance for water-retaining structures that could be useful for reviewing their serviceability. The regulatory guide suggests the following criteria which, as a minimum, should be part of the licensee's maintenance program:

* * * *

Drainage Systems. All drainage systems should be examined to determine whether the systems can freely pass discharge and to ensure that the discharge is not carrying embankment or foundation material. Systems used to monitor drainage should be examined to ensure they are operating correctly.

* * * *

In general, all massive water-retaining structures should not have areas of differential settlement or construction joint gaps that allow water to leak beneath the structure thereby causing soil erosion and concrete deterioration.. . . . Reinforced and unreinforced concrete surfaces should be visually inspected in accordance with ACI Committee 207 Report, “Practices for Evaluation of Concrete in Existing Massive Structures for Service Conditions.”